Alexandria Journal of Veterinary Sciences
www.alexjvs.com

AJVS. Vol. 59 (1): 34-42 Oct. 2018
DOI: 10.5455/ajvs.277323

A Retrospective Study of Carcass and Organ Condemnations at a Beef Abattoir in Namibia

Oscar Madzingira, Simbarashe Chinyoka, Justin Yule, Evelyn Nanjeke Mwenda, Erick Kandiwa, Alaster Samkange, Borden Mushonga

University of Namibia, Directorate of Veterinary Services, Namibia.

Key words:
beef abattoir; condemnations; causes; financial losses

***Correspondence to:**
Alaster Samkange
(alastersamkange@gmail.com)

ABSTRACT

This retrospective study investigated the causes of beef carcass and organ condemnations and the associated financial losses at a high throughput abattoir in Katima Mulilo, Namibia, from 2009 to 2013. Post-mortem meat inspection records from September 2009 to July 2013 that were kept at the abattoir were analyzed. Of the 26,957 cattle slaughtered during the study period, 59 whole carcasses, 13,884 livers, 13,161 lungs, 406 hearts, 33 kidneys, 265 pluck, 563 spleens, 163 heads, 160 tongues and 79 intestines were condemned. Whole carcasses were condemned mainly due to generalized *Cysticercus bovis* cysts (40.7%) and cachexia (39%). Among the organs, livers (51.5%) and lungs (48.8%) had the highest levels of condemnation. Liver flukes and hydatid cysts were responsible for most of the liver condemnations (65% and 17.1%, respectively), while hydatid cysts (63.4%) and abscesses (15.4%) were responsible for most of the lung condemnations. Fecal contamination (68.7%) and pericarditis (19.7%) were identified as the major cause of heart condemnations. Fecal contamination (43.6%, 32.5%), abscesses (41.7%, 45%) and *C. bovis* cysts (14.7%, 15%) were responsible for head and tongue condemnations, respectively. About 7.5% of the tongues were also condemned for floor contamination. Abscesses (49.4%), *C. tenuicollis* cysts (34.2%), nodular worm (13.9%) and floor contamination (2.5%) were responsible for condemnations of intestines. Fecal contamination (98.4%), floor contamination (0.9%) and splenitis (0.7%) were responsible for condemnations of spleens. Nephritis was the only recorded reason for the condemnation of kidneys. Total monetary losses due to carcass and organ condemnations over the study period were estimated at US$143,711.08. Although there was a 0.2% proportional condemnation of whole carcasses, these were responsible for 17.5% of the revenue losses (US$25,149.44). About 65.0% and 30.5% of the rest of the revenue losses were due to liver and lung condemnations, respectively. The rest of the causes were collectively responsible for only 3.71% of the overall revenue losses. Zoonotic parasites, *C. bovis*, fasciolosis and hydatid cysts were identified as the major causes of carcass and organ condemnations constituting a major public health concern.

Considering the size of the local economy, the revenue losses due to carcass and organ condemnations were quite high. This necessitates education of the stakeholders and the general public on the health and economic implications conveyed by this study.

1. INTRODUCTION

Beef cattle production is the major agricultural activity in Namibia with a contribution of about 10% to the gross domestic product (Kruger and Lammerts-Imbuwa, 2008; Mushendami and Gaomab, 2008). It is a source of livelihood for many farmers and a pillar of food security for the population. A greater proportion of the beef produced at high throughput abattoirs in the

country is exported to high value markets that include the European Union countries and South Africa.

Abattoirs provide an environment for the hygienic processing of beef. Meat slaughtered at abattoirs undergoes ante-mortem as well as post-mortem meat inspection before it is passed for human consumption (Habarugira et al., 2016; Jaja et al., 2016). In export abattoirs in Namibia, post-mortem inspection is carried out by trained and dedicated meat examiners following guidelines in the Food and Agriculture Organisation manual (Herenda et al., 1994) and an adopted version of the Meat Safety Act of the Republic of South Africa (Act No. 40 of 2000) (Government of the Republic of South Africa, 2000). Meat inspection does not eliminate biological hazards, but serves to remove from the food chain grossly visible conditions and contamination that pose a risk to public health (Mummed and Webb, 2015). Risks to public health include zoonotic diseases such as cysticercosis, tuberculosis, hydatidosis and brucellosis (Swai and Schoonman, 2012) and other meat associated microbial pathogens such as *Campylobacter* spp, pathogenic *Escherichia coli* and *Salmonella* spp which can cause severe diarrhea and even death. Therefore, a thorough meat inspection process is integral to the production of safe meat for the consumer (Hajimohammadi et al., 2014; Jaja et al., 2017a).

Furthermore, meat inspection provides opportunities for syndromic passive surveillance and early detection of the incidence of zoonotic and other infectious diseases of trade and political significance such as foot and mouth disease (Gracey et al., 1999). It also gives a key-hole view of the disease status of cattle populations (Assefa and Tesfay, 2013; Stärk, 2017). In some cases, meat inspection may be the only avenue for the detection of emerging and subclinical or chronic animal diseases such as contagious bovine pleuropneumonia (CBPP). Abattoirs also provide information that is useful for determining the likelihood and extent of public exposure to zoonotic and occupational diseases (Usman and Belay, 2016). This information is useful when designing preventive and control measures against zoonotic diseases.

Condemnation and appropriate disposal of carcasses and organs affected by zoonotic conditions is invaluable for the protection of public health. However, avoidable condemnations resulting from conditions such as bruising are an unnecessary financial loss to the farmer and wastage of protein that is required to meet the nutritional requirements of the population in poor countries of the developing world. Direct financial losses resulting from meat condemnation vary widely. For instance estimates from liver condemnations alone have been estimated to be US$8932.40 (Habarugira et al., 2016), US$44,667 (Ibironke and Fasina, 2010), US$ 221493.01 (Wolde and Tamiru, 2017) per annum and US$45,271.07 over a three year period (Jaja et al., 2017b). Besides financial losses related to meat condemnations, conditions identified at post-mortem inspection such as hydatidosis, cysticercus bovis, fasciolosis, cirrhosis and abscessation negatively impact animal productivity (Borji et al., 2012) and thus there is need to appraise the farming community of such occult losses.

There has been an increase in the availability of recent literature on meat condemnation and financial losses literature coming from Ethiopia (Bekelle et al., 2017; Hussein et al., 2017; Meaza et al., 2017; Wolde and Tamiru, 2017). Reports from other countries indicate that the major causes of bovine carcass condemnation include jaundice (Ochi et al., 2015), cysticercosis (Mummed and Webb, 2015; Jaja et al., 2017b), poor bleeding (Jaja et al., 2016), bovine tuberculosis (Habarugira et al., 2014), and bruising (Mummed and Webb, 2015). Hydatidosis, cysticercosis, fasciolosis, cirrhosis, abscesses, bovine tuberculosis, emphysema, pneumonia, hydronephrosis, percicarditis, nephritis, splenitis (Ibironke and Fasina, 2010; Ochi et al., 2015; Efrem et al., 2015; Usman and Belay, 2016; Jaja et al., 2017a) have been reported as the main causes of organ condemnations.

Reports on causes of meat condemnation at abattoirs or their financial implications in Namibia are limited. Available information has only focused on *Cysticercus bovis* (Shikongo-Kuvare, 2007) and the situation regarding carcasses and organ condemnations has, hitherto, been largely speculative. This study was therefore carried out to find out the causes and reasons for carcass and organ condemnations including diseases of public health significance and to estimate the direct financial losses resulting from meat condemnations at an abattoir between 2009 and 2013.

2. MATERIALS AND METHODS:

2. 1. Study area and animals

The study was carried out at an abattoir located in Katima Mulilo town (latitude 17°30′00″S and longitude 24°16′00″E) in the Zambezi region of Namibia. The Zambezi region is situated in the northeastern part of Namibia. The climate of the region is divided into wet (October-April) and dry seasons (May-September). The region receives more rainfall

annually (550-700mm) than the rest of the country during the wet season. Hot and humid temperatures of up to 33^{o}C are experienced during the summer months. Little or no rain is received during the dry season which is dominated by cold winter weather. The majority of people in the region are rural subsistence farmers who depend on cattle and rain-fed crop production for sustenance. As of 2012, there was an estimated 136 221 cattle in the region (Directorate of Veterinary Services, 2012). The abattoir was the major destination for beef cattle in the region and thus the animals included in this study were representative of the region. Slaughter weight male and female cattle of different breeds and from different districts within the Zambezi region were slaughtered at the abattoir. Between 242 and 1,207 cattle were slaughtered at the abattoir each month.

2.2. Study design

A cross-sectional study design utilizing retrospective data stored at the abattoir by meat inspectors was employed. Direct financial losses were estimated using the current average market prices for typical carcasses and organs.

2.3. Data collection

A retrospective study was undertaken using post-mortem meat inspection records from September 2009 to July 2013 that were compiled and kept by meat inspectors assigned by the Ministry of Agriculture, Water and Forestry and supervised by State Veterinarians. Data comprising of carcass and offal condemnations of 26,957 cattle slaughtered at a high throughput abattoir in the region was retrieved with permission, collated and analyzed. The data had been recorded daily over the study period and included the number of cattle slaughtered and the number and reasons for carcass and organ condemnations. Post-mortem meat inspection and judgement on meat at this abattoir was done following standard procedures as described by the Food and Agriculture Organization (Herenda et al., 1994). Data for the years prior to 2009 was excluded due to inconsistent records. Data on breed, sex, and age and ante-mortem inspection of slaughtered cattle was not available.

The total number of cattle slaughtered, the number of carcasses and organs rejected and the foregoing market rate for meat were used to estimate direct financial losses incurred due to condemnations over the study period.

2.4. Statistical analysis

The retrospective data was uploaded into a Microsoft Excel® (Excel 2013) database. Descriptive statistics using proportions and percentages were used to determine condemnation rates for carcasses and organs. Data were imported into Statistical Package for Social Sciences (SPSS) version for statistical analysis. The Z test for comparison of proportions was used and $p \leq 0.05$ was considered significant.

3. RESULTS

Bovine livers (51.5%) and lungs (48.8%) had the highest levels of condemnations. The proportion of condemned livers were significantly greater than those of the condemned lungs and the rest of the condemned parts ($p<0.05$). Except for condemned heads and tongues, there were significant differences between the proportional condemnation of all the organs and body parts ($p<0.05$). Details of judgements made on carcasses are shown in Table 2: *Cysticercus bovis* cysts (40.7%) and cachexia (39%) were the major causes of total condemnation of cattle carcasses. Other causes of bovine carcass condemnation were bruising, pus contamination, anemia, poor bleeding and fecal contamination. There was no significant difference between the proportion of carcass condemnations due to *C. bovis* cysts and that due to cachexia ($p>0.05$). However, these condemnations were significantly greater than those due to the other causes ($p<0.05$).

Table 1: Overall proportional condemnation at Katima abattoir from 2009 to 2013

Condemned Part	Number condemned	Proportion (%)	Number not condemned	Proportion (%)	Total
Whole Carcasses	59	0.2	26,898	99.8	**26,957**
Livers	13,884	51.5	13,073	48.5	**26,957**
Lungs	13,161	48.8	13,796	51.2	**26,957**
Hearts	406	1.5	26,551	98.5	**26,957**
Kidneys	33	0.1	26,924	99.9	**26,957**
Pluck	265	1.0	26,692	99.0	**26,957**
Spleens	563	2.1	26,394	97.9	**26,957**
Heads	163	0.6	26,794	99.4	**26,957**
Tongues	160	0.6	26,797	99.4	**26,957**
Intestines	79	0.3	26,878	99.7	**26,957**

Table 2: Causes of bovine carcass condemnations

Cause of condemnation	Number condemned	Proportion (%)
C. bovis cysts	24	40.7
Cachexia	23	39.0
Bruising	7	11.9
Pus contamination	2	3.4
Anemia	1	1.7
Poor bleeding	1	1.7
Fecal contamination	1	1.7
Overall	**59**	**0.2**

As shown in Table 3, livers and lungs were significantly the major organs condemned at meat inspection ($p<0.05$). Liver condemnations (51.5%) were significantly higher than lung condemnations (48.8%) ($p<0.05$). Liver flukes and hydatid cysts were responsible for most of the liver condemnations (65% and 17.1%, respectively). The proportion of condemnations due to liver fluke was significantly greater than that due hydatid cysts ($p<0.05$). Angioma (0.3%) and cirrhosis (0.1%) were the least causes of liver condemnations. The proportional condemnation due to angioma was, however, significantly greater than that due to cirrhosis ($p<0.05$).

Hydatid cysts and abscess were responsible for most of the lung condemnations (63.4% and 15.4%, respectively) and the proportion of condemnations due to hydatid cysts was significantly greater than that due to abscesses ($p<0.05$). Floor contamination (0.2%) and lungworm (0.2%) were the least causes of lung condemnations. There was no significant difference in the proportional condemnations due to floor contamination and lungworm ($p>0.05$).

Fecal contamination (68.7%) and pericarditis (19.7%) were responsible for most of the heart condemnations and the proportion of condemnations due to fecal contamination was significantly greater than that due to pericarditis ($p<0.05$). Floor contamination (4.7%) and pus contamination (1%) were the least causes of heart condemnations. The proportional condemnation due to floor contamination was, however, significantly higher than that due to pus contamination ($p<0.05$).

Fecal contamination (43.6%), abscesses (41.7%) and *C. bovis* cysts (14.7%) were responsible for head condemnations. There was no significant difference between the proportional head condemnations due to fecal contamination and abscesses ($p>0.05$), but the proportional condemnations due to both fecal contamination and abscesses were significantly greater than those due to *C. bovis* cysts ($p<0.05$).

Abscesses (45%), fecal contamination (32.5%), *C. bovis* cysts (15%) and floor contamination (7.5%) were responsible for tongue condemnations. Proportional condemnations due to abscesses were significantly greater than those due to fecal contamination ($p<0.05$). Floor contamination was significantly the least cause of tongue condemnations ($p<0.05$).

Abscesses (49.4%), *C. tenuicollis* cysts (34.2%), nodular worm (13.9%) and floor contamination (2.5%) were responsible for condemnations of intestines. There was no significant difference in the proportional condemnation of intestines due to abscess and *C. tenuicollis* cysts ($p>0.05$) though, however, they were both significantly greater than condemnations due to nodular worm and floor contamination ($p<0.05$). Floor contamination was significantly the least cause of condemnation of intestines ($p<0.05$).

Fecal contamination (98.4%), floor contamination (0.9%) and splenitis (0.7%) were responsible for condemnations of spleens. Fecal contamination was significantly the major cause of condemnation of spleens ($p<0.05$). There was, however, no significant difference between the proportional condemnation of spleens due to floor contamination and splenitis ($p>0.05$).

Nephritis was the only recorded reason for kidney condemnation. The proportion of kidney condemnation was significantly lower than the rest of the organs ($p<0.05$).

Total monetary losses due to carcass and organ condemnations over the study period were estimated at USD 143711.08. About 65.0% and 30.5% of these losses were due to liver and lung condemnations. The

rest of the causes were collectively responsible for only 4.5% of the revenue losses at Katima abattoir between 2009 and 2013.

Table 3: Causes of organ condemnation and the associated revenue losses

Reason for condemnation	Number condemned	Proportion (%)	Estimated total cost (US$)
Liver			
Liver fluke	9019	65.0	50,055.45
Hydatid cysts	2380	17.1	13,209.00
Fecal contamination	1088	7.8	6,038.40
Abscess	610	4.4	3,385.50
Peritonitis	466	3.4	2,586.30
Stilesia hepatica	276	2.0	1,531.80
Angioma	36	0.3	199.80
Cirrhosis	9	0.1	49.95
Overall	**13884**	**51.5**	**77,056.20**
Lungs			
Hydatid cysts	8350	63.4	22,962.50
Abscess	2031	15.4	5,585.25
Emphysema	1036	7.9	2,849.00
Fecal contamination	1130	8.6	3,107.50
Pneumonia	328	2.5	902.00
Pus contamination	144	1.1	396.00
Pleuritis	82	0.6	225.50
Floor contamination	30	0.2	82.50
Lungworms	30	0.2	82.50
Overall	**13161**	**48.8**	**36,192.75**
Heart			
Pericarditis	80	19.7	264.00
C. bovis cysts	24	5.9	79.20
Floor contamination	19	4.7	62.70
Fecal contamination	279	68.7	920.70
Pus contamination	4	1.0	13.20
Overall	**406**	**15.1**	**1,339.80**
Head			
Fecal contamination	71	43.6	819.34
Abscess	68	41.7	784.72
C. bovis cysts	24	14.7	276.96
Overall	**163**	**0.6**	**1,881.02**
Tongue			
Fecal contamination	52	32.5	240.24
Abscess	72	45.0	332.64
C.bovis cysts	24	15.0	110.88
Floor contamination	12	7.5	55.44
Overall	**160**	**0.6**	**739.20**
Intestines			
Abscess	39	49.4	90.09
C. tenuicollis cysts	27	34.2	62.37
Nodular worm/pimply gut	11	13.9	25.41
Floor contamination	2	2.5	4.62
Overall	**79**	**0.3**	**182.49**
Spleen			
Fecal contamination	554	98.4	1,063.68
Floor contamination	5	0.9	9.60
Splenitis	4	0.7	7.68
Overall	**563**	**2.1**	**1,080.96**
Kidney			

Nephritis	33	0.1	63.36
Overall	**33**	**0.1**	**63.36**
Grand total	**-**	**-**	**118,535.78**

4. DISCUSSION

This study investigated the causes and reasons for bovine carcass and organ condemnations and the associated financial losses using data from September 2009 to July 2013 at a selected high throughput abattoir in Namibia. Over the study period, the abattoir was the major marketing channel for cattle in the Zambezi region. Therefore, the data collected was representative of that region. A number of causes of carcass and organ condemnations were identified.

This study revealed that 59 cattle carcasses representing 0.2% of the animals slaughtered were condemned for various reasons over the study period, which is a relatively low proportion compared to 0.5% (Phiri, 2006) and 0.8% (Tembo and Nonga, 2015) reported in other studies in Zambia and Tanzania, respectively. The differences may be attributed to farmers selecting apparently healthy animals for slaughter and differences in slaughter numbers. The majority of bovine carcasses rejected for human consumption in this study had generalized *Cysticercus bovis* cysts (40.7%), cachexia (39%) or bruising (11.9%). The abattoir prevalence of *C. bovis* over the study period was 0.1%, which is comparable to the prevalence of 0.3% reported by Mellau *et al.* (Mellau et al., 2011), but lower than the prevalence of 8% reported by Shikongo-Kuvare (Shikongo-Kuvare, 2007) at Oshakati abattoir in Namibia. Although occurring at a much lower prevalence, *C. bovis* is a zoonotic parasite of public health importance. Coordinated efforts need to be put towards reducing the incidence of this zoonosis. Humans are definitive hosts of the adult tapeworm and infections may go undetected or cause serious disease including brain disease (Agegn et al., 2016). *Cysticercus bovis* is economically important due to the associated meat condemnations. Prevention and control measures especially the use of toilets for defecation, treatment of infected individuals and the regular washing of hands after toilet use (Oladele and Lesotho, 2010) need to be implemented to prevent further losses. As expected, in generalized bovine cystircercosis infections, hearts, tongues and heads were also condemned.

Out of the 59 condemned carcasses, 39% (n=23) were cachexic. Analysis of the data showed that cachexia was not associated with the time of the year or any specific year. It is presumed that these were culled animals with chronic conditions or animals that were in poor condition, probably due to the drought which the country often experiences. Bruising (11.9%) was one of the major causes of carcass condemnation. This figure is relatively low compared to other reports (Huertas et al., 2015). Bruises are not visible in live animals and it is therefore not possible to pin point the source of the injuries. However, bruises can occur at the time of loading, during transport to the abattoir, offloading or in the lairages when unfamiliar groups of animals comingle at the abattoir. Effective implementation of animal welfare procedures can reduce cases of partial or total condemnation of carcasses at meat inspection.

Livers (51.5%) followed by lungs (48.8%) were the major organs rejected at post-mortem meat inspection as has also been reported in other studies (Assefa and Tesfay, 2013; Ochi et al., 2015; Atawalna et al., 2016). A study in Zambia reported condemnation rates of livers and lungs of 47.6 and 51.2%, respectively (Banda et al., 2013); figures which are similar to the current study. These findings can be explained by the similarities of ecological and climatic conditions between the study areas. Fasciolosis and hydatidosis were the major causes of organ condemnation in this study, which is in agreement with another study in Ethiopia (Assefa and Tesfay, 2013). In the current study, liver flukes (65.0%) were the major cause of liver condemnations. These findings are similar to reports in other studies (Atawalna et al., 2016; Jaja et al., 2017b) and other researchers in Ethiopia (Assefa and Tesfay, 2013); Tanzania (Kamwela et al., 2013; Nzalawahe and Komba, 2013) and Nigeria (Njoku-Tony, 2011). Besides losses due to liver condemnations, fasciolosis decreases animal productivity (Kambarage et al., 1995). The high prevalence of liver flukes was expected because the parasite is endemic in the Zambezi region and the region receives the highest rainfall (500-700mm) in the country which results in flooding and swampy areas that favor the proliferation of the snail intermediate hosts (Kambarage et al., 1995)). Parasite control is very critical in the region. Hydatid cysts, fecal contamination, abscess, peritonitis, *Stilesia hepatica*, angioma and cirrhosis were also identified as causes of liver condemnations in this study. The causes of liver

abscesses and peritonitis need to be investigated so that preventive and control measures can be implemented. *Stilesia hepatica*, a common liver tapeworm of sheep and goats, was recorded in cattle at a prevalence of 0.1%. The parasite may have become adapted to cattle in a region where there are very few goat and sheep flocks.

Hydatid cysts were responsible for most lung condemnations (63.4%) as has been reported by other researchers in the tropics (Banda et al., 2013; Mummed and Webb, 2015). Hydatid cysts are an intermediate stage of a zoonotic parasite that uses dogs and other carnivores as definitive hosts. The high prevalence of hydatid cysts in the lungs suggests that dogs and other carnivores in the study area are infected with *Echinococcus granulosus* tapeworms and those communal pastures were contaminated with infected dog feces. Backyard slaughtering, poor public awareness and the feeding of dogs with offal promotes the life cycle of the parasite in a communal set up. Due to its zoonotic importance, public awareness and livestock extension services need to be implemented to reduce the disease burden on the human population (Tembo and Nonga, 2015).

In this study, all kidneys were condemned due to nephritis. These findings are in contrast with other studies in which hydronephrosis was the major cause of kidney condemnation (Denbarga et al., 2011), but similar to a high rejection rate due to pyelonephritis as reported in another study (Mesele et al., 2012). According to the latter study, the causes of heart condemnations were *C. bovis*, pericarditis and pus contamination (Mesele et al., 2012), which is in agreement with the current study. In the former study, *C. bovis* was the major cause of heart rejections, while in this study; pericarditis was the major cause of heart condemnations. The cause of pericarditis could be related to ingested foreign metals or wires or to an infectious cause and these need to be investigated. Intestines were rejected mainly due to abscesses and the cause was not identified. Other studies have reported pimply gut as the major condition causing the condemnation of bovine intestines (Tembo and Nonga, 2015).

This study revealed that the greatest financial losses were due to the condemnation of livers, followed by lungs and carcasses, in descending order. The financial losses were attributed to fasciolosis, hydatid cysts and *C. bovis* infections. The overall loss of USD 143711.08 reported over the five year study period was relatively high compared to losses reported by other workers (Assefa and Tesfay, 2013), but lower than losses reported at an abattoir in Nigeria (Cadmus and Adesokan, 2009) and comparable to losses of USD 118 702 over a three-year period in Zambia (Tembo and Nonga, 2015). There is a wide variation in financial losses associated with meat condemnation in the literature. This variation may be due to differences in methodologies, slaughtering capacities, market prices for meat, animal management practices and disease prevalence (Assefa and Tesfay, 2013). Losses of any magnitude reduce farmers' income and affect the social and economic well-being of communities (Tembo and Nonga, 2015).

The zoonotic parasites *Cysticercus bovis*, fasciolosis and hydatid cysts were identified as the major cause of carcass and organ condemnations.

5. CONCLUSION

Strategic measures need to be implemented to control parasitic infections in cattle, dogs and humans in order to reduce the incidence of parasitic condemnations as well as the public health implications of zoonoses.

The identification of zoonotic infections in meat shows that the health of abattoir workers, consumers and animal handlers are at risk. Inappropriate carcass dressing techniques contributed to the avoidable rejection of meat due to pus, fecal and floor contamination. This study also identified abscesses, peritonitis, angioma, cirrhosis, anemia, poor bleeding, emphysema, pneumonia, splenitis, nephritis, pleuritis and pericarditis as causes of meat condemnations that may be associated with infectious causes and requiring further investigation to identify the etiology and reduce incidence. Aesthetic causes of meat rejection such as generalized bruising, Stilesia hepatica, C. tenuicollis, lungworms, nodular worms and cachexia were also identified. It is recommended that the results of meat inspection be regularly communicated to responsible veterinarians and public health officials for trace back to affected areas and control of the specified diseases in animals and humans. The major financial losses were attributable to the condemnation of livers.

6. ACKNOWLEDGEMENTS

The authors would like to thank the Meat Corporation of Namibia as well as the Ministry of Agriculture, Water and Forestry for availing the records which were invaluable for conducting this study. A special thanks also goes to the University of Namibia for funding the publication of this manuscript.

REFERENCES

Agegn, M., Tegegne, B., Tibebu, S. 2016. Major Causes of Organ and Carcass Condemnation in Cattle and Sheep Slaughtered at Bahir-Dar Municipal Abattoir, Amhara Regional State, Ethiopia. Adv. Biol. Res. (Rennes). 10:323–334.

Assefa, A., Tesfay, H. 2013. Major causes of organ condemnation and economic loss in cattle slaughtered at adigrat municipal abattoir, northern ethiopia. Vet. World 6:734–738.

Atawalna, J., Gbordzi, M., Emikpe, B.O., Anyorigeyah, T. 2016. International Journal of Veterinary Science Whole Carcass and Organ Condemnation and Their Associated Financial Losses in Ruminants Slaughtered At the Bolgatanga Municipal Abattoir of Ghana. Int. J. Vet. Sci. 5:5–9.

Banda, F., Nalubamba, K.S., Muma, J.B., Munyeme, M., Mweemba Munang'andu, H. 2013. A Cross-Sectional Study Investigating Cystic Hydatidosis in Slaughtered Cattle of Western Province in Zambia. ISRN Parasitol. 2013:1–9.

Bekelle, T., Gebreyohannes, M., Tesfaye, A. 2017. Identification of pulmonary lesions in slaughtered cattle and associated risk factors, North West Ethiopia. African J. Agric. Res. 12:1447–1450.

Borji, H., Azizzadeh, M., Kamelli, M. 2012. A Retrospective Study of Abattoir Condemnation Due to Parasitic Infections: Economic Importance in Ahwaz, Southwestern Iran. J. Parasitol. 98:954–957.

Cadmus, S.I.B., Adesokan, H.K.: 2009. Causes and implications of bovine organs/offal condemnations in some abattoirs in Western Nigeria. Trop. Anim. Health Prod. 41:1455–1463.

Denbarga, Y., Demewez, G., Sheferaw, D. 2011. Major causes of organ condemnation and financial significance of cattle slaughtered at gondar elfora abattoir, Northern Ethiopia. Glob. Vet. 7:487–490.

Directorate of Veterinary Services. 2012. Annual Report. Windhoek, Namibia.

Efrem, L., Serda, B., Sibhat, B., Hirpa, E. 2015. Causes of organ condemnation, its public health and financial significance in Nekemte municipal abattoir, Wollega, Western Ethiopia. J. Vet. Med. Anim. Heal. 7:205–214.

Government of the Republic of South Africa. 2000. Meat Safety Act. Parliament of the Republic of South Africa, Pretoria.

Gracey, J.F., Collins, D.S., Huey, R.J. 1999. Poultry production, slaughter and inspection, in: Gracey, J., D.S., C., Huey, R.J. (Eds.), Meat Hygiene. W.B. Saunders Co. Ltd., New York, pp. 261–287.

Habarugira, G., Mbasinga, G., Mushonga, B., Chitura, T., Kandiwa, E., Ojok, L. 2016. Pathological findings of condemned bovine liver specimens and associated economic loss at Nyabugogo abattoir, Kigali, Rwanda. Acta Trop. 164:27–32.

Habarugira, G., Rukelibuga, J., Nanyingi, M.O., Mushonga, B. 2014. Bovine tuberculosis in Rwanda: Prevalence and economic impact evaluation by meat inspection at Société des Abattoirs de Nyabugogo-Nyabugogo Abattoir, Kigali. J. S. Afr. Vet. Assoc. 85:1062.

Hajimohammadi, B., Oryan, A., Zohourtabar, A., Ardian, M., Shokuhifar, M. 2014. Rate of carcass and offal condemnation in animals slaughtered at Yazd Slaughterhouse, central Iran. Asian Pac. J. Trop. Biomed. 4:736–739.

Herenda, D., Chambers, P.G., Ettriqui, A., Seneviratna, P., Da Silva, T.J.P. 1994. Manual on meat inspection for developing countries. Food and Agriculture Organization of the United Nations, Rome, Italy.

Huertas, S.M., van Eerdenburg, F., Gil, A., Piaggio, J. 2015. Prevalence of carcass bruises as an indicator of welfare in beef cattle and the relation to the economic impact. Vet. Med. Sci. 1: 9–15.

Hussein, A., Kemal, J., Regassa, A. 2017. Prevalence , Organ Distribution , Cyst Viability and Financial Losses of Bovine Hydatidosis in Shashemene Municipal ... J. Sci. Sustain. Dev. 5:57–71.

Ibironke, A., Fasina, F. 2010. Socio-economic implications of bovine liver rejection in a major abattoir in south-western Nigeria. Rev. Ciências Agrárias 33:211–216.

Jaja, I.F., Mushonga, B., Green, E., Muchenje, V. 2017a. Seasonal prevalence, body condition score and risk factors of bovine fasciolosis in South Africa. Vet. Anim. Sci. 4. 1–7.

Jaja, I.F., Mushonga, B., Green, E., Muchenje, V. 2017b. A quantitative assessment of causes of bovine liver condemnation and its implication for food security in the eastern cape province South Africa. Sustain. 9.

Jaja, I.F., Mushonga, B., Green, E., Muchenje, V. 2016. Prevalence of lung lesions in slaughtered cattle in the Eastern Cape Province , South Africa. J. S. Afr. Vet. Assoc. 87:1–9.

Kambarage, D.M., Kimera, S.I., Kazwala, R.R., Mafwere, B.M. 1995. Disease conditions responsible for condemnation of carcasses and organs in short-horn Zebu cattle slaughtered in Tanzania. Prev. Vet. Med. 22:249–255.

Kamwela, K.M., Kassuku, A.A., Nonga, H.E. 2013. Prevalence and financial losses associated with Bovine fasciolosis at SAAFI and Sumbawanga municipal abattoirs, Rukwa, Tanzania. Tanzania Vet. J. 28:14–22.

Kruger, B., Lammerts-Imbuwa, L. 2008. Namibia National Farmers Union (NNFU) Training Manual Livestock Marketing in Namibia. Namibia National Farmers Union, Windhoek, Namibia.

Meaza, M., Keda, A., Serda, B., Sulayman, M. 2017. Prevalence, gross pathological lesions and financial losses of bovine Fasciolosis in Arba Minch Municipal Abattoir, Gamo Gofa Zone, Southern Ethiopia. J. Vet. Med. Anim. Heal. 9:186–192.

Mellau, B.L., Nonga, H.E., Karimuribo, E.D. 2011. Slaughter stock abattoir survey of carcasses and organ/offal condemnations in Arusha region, northern Tanzania. Trop. Anim. Health Prod. 43:857–864.

Mesele, G., Guadu, T., Bogale, B., Chanie, M. 2012. Pathological Conditions Causing Organ and Carcass Condemnation and Their Financial Losses in Cattle Slaughtered in Gondar , Northwest Ethiopia. African J. Basic Appl. Sci. 4:200–208.

Mummed, Y.Y., Webb, E.C. 2015. Causes of beef carcass and organ condemnations in Ethiopia. Asian J. Anim. Vet. Adv. 10:147–160.

Mushendami, P., Gaomab, M. 2008. Unleashing the potential of the agricultural sector in Namibia. Windhoek.

Njoku-Tony, R.F. 2011. Bovine Fascioliasis Among Slaughtered Cattle In Selected Abattoirs In Imo State, Nigeria. World Rural Obs. 3: 59–63.

Nzalawahe, J., Komba, E.V.G. 2013. Research opinions in animal and veterinary sciences. Res. Opin. Anim. Vet. Sci. 3:395–400.

Ochi, E.B., Simplisio, E.A., Ismail, A.O. 2015. A Retrospective Study on the Major Causes of Meat Condemnations in Animals Slaughtered in Juba County South Sudan. Int. J. Bioassays 4:4620–4624.

Oladele, O.I., Lesotho, K. 2010. Determinants of cattle farmers' awareness and attitude towards prevention and control of Cysticercus bovis in Botswana. Livest. Res. Rural Dev. 22.

Phiri, A.M. 2006. Common conditions leading to cattle carcass and offal condemnations at 3 abattoirs in the Western Province of Zambia and their zoonotic implications to consumers. J. S. Afr. Vet. Assoc. 77: 28–32.

Shikongo-Kuvare, L.T. 2007. Development of risk communication strategies to improve control of Cysticercosis bovis in north-central Namibia. University of Pretoria.

Stärk, K.D.C. 2017. Abattoir condemnation data remain under-used in decision making. Vet. Rec. 180: 514–515.

Swai, E.S., Schoonman, L. 2012. A survey of zoonotic diseases in trade cattle slaughtered at Tanga city abattoir: A cause of public health concern. Asian Pac. J. Trop. Biomed. 2: 55–60.

Tembo, W., Nonga, H.E. 2015. A survey of the causes of cattle organs and/or carcass condemnation, financial losses and magnitude of foetal wastage at an abattoir in Dodoma, Tanzania. Onderstepoort J Vet Res 82: 1–7.

Usman, N., Belay, A. 2016. Study on the Major Problems that Causes Carcass and Organs Condemnation and Associated Financial Losses at Elfore Export Abattoir, Bishoftu, Ethiopia. J. Biol. Agric. Healthc. 6: 17–27.

Wolde, T., Tamiru, T. 2017. Incidence and economic impact of fasciolosis in Wolkite town, Community Abattoir. J. Vet. Med. Anim. Heal. 9: 116–120.